Beitrag ID: **13** Typ: **Poster**

Dynamic Wetting of Adaptive Polyelectrolyte Substrates: A multiscale approach

Donnerstag, 20. Februar 2025 11:50 (20 Minuten)

Wetting phenomena are of great importance across various scientific disciplines, and as a fundamental research area, the wettability dynamics of adaptive substrates, such as polyelectrolyte multilayers (PEM), have gained significant attention. Notably, an interesting property of polyelectrolyte (PE) substrates is their propensity to swell in a liquid environment. However, the complexities such as the disparity between time and length scales and surface deformation beyond the three-phase contact line (TPCL), make experimental investigations quite challenging.
We prepared PE substrates by the layer-by-layer method invented by Decher [1], with a focus on their wettability at the nanoscale. We used atomic force microscopy (AFM) as the main characterisation technique at the nanoscale for investigation of properties like layer morphology, swelling kinetics, etc. Also, an optical contact angle (CA) tensiometry method is used for macroscopic measurements. The layer thickness is determined by ellipsometry and X-ray reflectometry (XRR). Previous results show that the water CA on silicon wafers coated with polystyrene sulfonate (PSS) as outermost layer decreases in water-saturated atmosphere [2]. To investigate the dependence on layer thickness, polymer chain length and overall charge of the outermost layer, different PEMs consisting of PEI, PSS and PAH were fabricated and characterised. Here, the substrates were investigated with an AFM and showed to exhibit very smooth surfaces while linearly increasing in thickness. Furthermore, the decrease in water CA is more pronounced with an increasing layer thickness and differs if PSS or PAH are outermost layer. [3]

[1] G. Decher, Science 1997, 1232 –1237.
[2] K. Hänni-Ciunel, G. H. Findenegg, R. v. Klitzing, Soft Materials 2007, 61 –73.
[3] The authors acknowledge funding from the DFG, Priority program 2171, KL1165/34, Grant Number 505842923.

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Sitzung Einordnung: Poster Session